

Urine Pretreatment Methods for Microgravity

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Pretreatment of urine is required in space station waste-water recovery systems to control urea and its resulting odors and microbial growth. Also, recent testing and experience on the shuttle orbiter waste-water plumbing indicated that pretreatment is required for long-term use of urine separator hardware to reduce or eliminate fouling of the hardware and plumbing with urine precipitates. This is important for *International Space Station* application because the amount of maintenance time for cleaning and repairing hardware must be minimized. The method of choice for urine pretreatment for the U.S. water reclamation system is Oxone®, a monopersulfate compound, and sulfuric acid (H₂SO₄). Development and initial testing of an effective method to inject these into a urine stream in microgravity is the focus of this effort. The first phase of this work concentrated on Oxone® and was performed from September 1994 to May 1995. The sulfuric acid injection design is continuing through 1995.

The method of introducing Oxone® into the urine stream on-orbit is quite a technical challenge. Oxone® in a powder form is not easily metered into a fluid stream in microgravity, and the efficacy in solution significantly degrades over time so that it is not practical to launch the chemical in a liquid form that would be easy to inject into the system.¹

A trade study to determine an appropriate method of injecting Oxone® indicated that a solid tablet of Oxone® added at the inlet of the urinal would adequately pretreat the urine and protect the urinal. The tablet was a mixture of Oxone® powder and polyethylene glycol, and was encased in the same material currently used for the urinal inlet filter. The tablets were first tested in a dissolution test; then the prototype filter and tablets were used in a 30-day test to validate the ability for treating real urine.

The dissolution test determined a baseline dissolution rate, allowed visual observation of fluid

flowpatterns, and measured and recorded the pressure drop across the solid Oxone® in several configurations using water at body temperature.² Figure 95 shows the data measured in the baseline dissolution test. As the tablets dissolve (the rate of dissolution decreased as the tablets got smaller), the surface area of the tablet became smaller, and less pretreatment was added to the stream. The test used six tablets, weighing 31.8 grams total. The tablets tended to dissolve from the outside first, did not break apart, and dissolved in one piece (staying inside the filter encasement so that no undissolved Oxone® went downstream to the separator).

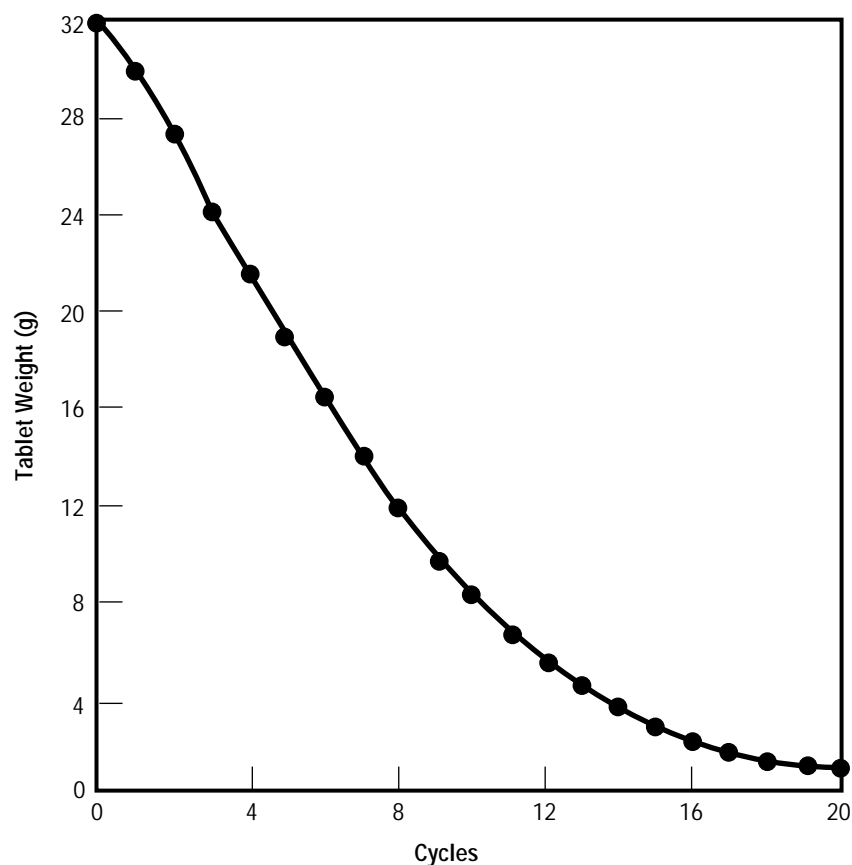


FIGURE 95.—Oxone® tablet dissolution rate.

After dissolution testing, a 30-day test to evaluate the prototype method for injecting proper levels of Oxone® safely and conveniently into the separator was completed. Tablet dissolution was measured on a batch basis: a batch of urine consisted of the amount of urine needed to dissolve nearly all of the Oxone® in the filter. The remaining Oxone® was measured to get a ratio of the pretreatment and urine which had gone through the filter. Data on the pretreated urine were collected to measure the efficacy of the pretreatment used in this method. (The pretreatment was modified slightly during the test in order to optimize the amount of Oxone® used.)

The 30-day prototype test data are shown in figure 96. After several batches, the percent of polyethylene glycol by weight was modified to increase the binding efficacy, and the method of compressing the tablets was improved so that the tablets were more consistent. This caused the pretreatment/urine ratio to be closer to the goal of 5 grams of Oxone® per liter of urine (fig. 96). The pH of the pretreated urine was generally between 4 and 5, which is exactly what would be expected when pretreating with Oxone® alone. The oxidation potential in the stored pretreated urine was very low (an average of 0.016 percent), indicating that the pretreatment was adequately pretreating the urine but had not been exhausted. The amount of Oxone® left at the end of the batch averaged 0.22 grams. Subjective judgment of the odor/bacteria filter during the test indicated that the odor/bacteria filter was loading at a lower rate than with no pretreatment. (The low odor level

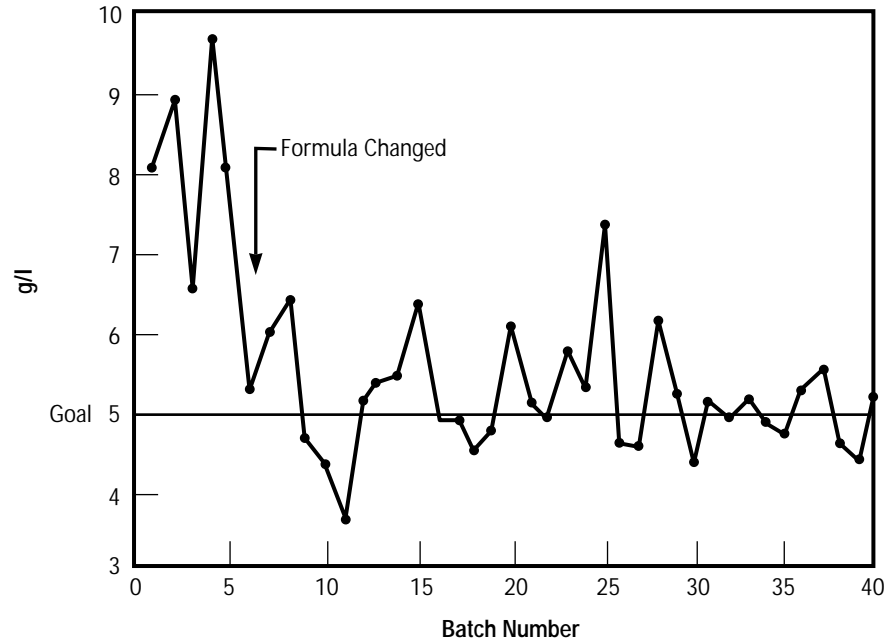


FIGURE 96.—Pretreatment-to-urine ratio per batch.

will lead to logistics savings.) After forty test days and processing a total of 750 pounds of urine, the separator and adjoining plumbing were disassembled for a thorough inspection and found to be completely free of precipitates. The separator pitot tube was clear of any residue, and all of the hoses were clean.

The trade study completed in this effort pointed to a simple method of urine pretreatment that will optimize weight, power, and volume. The success of this testing has been a major step in finding a final urine pretreatment design for the *International Space Station* and for ensuring prevention of urine collection hardware degradation due to fouling and urine solids buildup. This translates as less maintenance and lower logistics. Work is underway to find a suitable injection method for sulfuric acid.

¹Oxone®-Monopersulfate Compound Technical Sheet, DuPont.

²Rethke, D.W. February 1995. Test Plan for Urine Pretreat Injection System. Hamilton Standard, Space and Sea Systems, Windsor Locks, Connecticut.

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